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Micronutrient intake in advanced age: Te Puāwaitanga o Ngā Tapuwae Kia ora Tonu, Life and Living in Advanced Age: A Cohort Study in New Zealand, LiLACS NZ)

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Abbreviations: LiLACS NZ, Life and Living to Advanced age a Cohort Study in New Zealand; NZ, New Zealand; NZANS, New Zealand Adult Nutrition Survey; EAR, Estimated Average Requirement; RDI, Recommended Dietary Intake; NZ Dep, NZ Deprivation Index; 24h MPR, 24 hour multiple pass recall; NZFCDB, NZ Food Composition Database; NRVs, Nutrient Reference Values; EI, Energy Intake; AI, Adequate Intake; AMDR, Acceptable Macronutrient Distribution Range.

Abstract

A high prevalence of undernutrition has previously been reported in indigenous Māori (49%) and non-Māori (38%) octogenarians and may be associated with risk of micronutrient deficiencies. We examined vitamin and mineral intake and contributing food sources among 216 Māori and 362 non-Māori participating in LiLACS NZ; using a repeat 24 hour Multiple Pass Recall. More than half of the Māori and non- Māori participants had intakes below the estimated average requirement (EAR) from food alone for calcium, magnesium and selenium. Vitamin B_6 (Māori women only), folate (women only), vitamin E (Māori women; all men), and zinc (men only) were low in these ethnic and gender subgroups. Women had intakes of higher ~~-~~nutrient density in folate, vitamin C, calcium, magnesium, potassium, vitamin A (non-Māori) and β-carotene (Māori) compared to men ($p<0.05$). When controlling for age and physical function β-carotene, folate, vitamin C, calcium and magnesium were~~are~~ no longer significantly different but vitamin B_2, B_{12}, E, D, iron, sodium, selenium and zinc beca~~o~~me significantly different for Māori between men and women. When controlling for age and physical function vitamins A, C and calcium are no longer significantly different but vitamin B_2, iron, sodium and zinc become significantly different for non-Māori between men and women. For those who took nutritional supplements Māori were less likely to be deficient in food alone intake of vitamin A, folate and magnesium while non-Maori were less likely to be deficient in intake of magnesium, potassium and zinc, but more likely to be deficient in vitamin B_{12}. A lack of harmonisation in nutrient recommendations hinders the interpretation of nutrient adequacy nonetheless calcium, magnesium and selenium are key micronutrients of concern. Milk and cheese provided important contributions to calcium intake while bread was~~is~~ a key source of magnesium and selenium. Examination of dietary intake related to biochemical status and health outcomes will establish the utility of these observations.

Introduction

The number of New Zealanders aged 85+ years is projected to increase six-fold by 2051; an increase from 9 percent to 22 percent of the 65+ population. Māori are the indigenous people of Aotearoa, New Zealand comprising 14% of the total population and 2% of those aged over 80 years [(1)]. However, the population of Māori aged over 80 years is increasing ~~expanding~~ faster than the non-Māori octogenarian population[(2)]. With the anticipated increase in the population aged 80 years and over the ~~; therefore~~ nutrition-related health of the oldest old, both Māori and non- Māori is a major public health concern[(3)].

People in advanced age experience a significant variation in age related functional changes and have a diverse range of nutritional needs. They also experience a disproportionately high risk of malnutrition and nutrition related- health problems as a result of inadequate food and nutrition intake[(4)]. In a cohort study of those in advanced age (Te Puāwaitanga o Ngā Tapuwae Kia ora Tonu~~Te Puawaitanga o Nga Tapuwae Kia Ora Tonu~~, Life and Living in Advanced Age: A Cohort Study in New Zealand, LiLACS NZ), half (49%) of indigenous Māori and 38% of non-Māori octogenarians were assessed~~s~~ as being ~~-~~at high nutrition risk using a validated questionnaire Seniors in the Community: Risk Evaluation for Eating and Nutrition[(5)].

Micronutrient deficiencies tend to arise due to a reduction in food intake in response to a decline in energy needs with age. Basal metabolism and energy expenditure for physical activity may be reduced[(6)] while vitamin and mineral needs remain unchanged or are increased[(7)]. Physiological changes may impact the absorption, transport, metabolism and excretion of nutrients[(8)] and poor health and medications can cause nutrient malabsorption[(9; 10)]. Eating habits affected by poor oral health and social isolation may further contribute to lower food intake and nutrient deficiency [(11; 12; 13)]. Older people are especially susceptible to vitamin D insufficiency due to reduced mobility, decreased sun exposure and a decline in cutaneous synthesis of vitamin D with age[(14)]. As micronutrient deficiencies are associated with adverse functional outcomes[(15)] they may impact the independence of older adults. Therefore, an understanding of micronutrient intake of those in advanced age is needed. In New Zealand (NZ) there are no nutrients for which the R~~r~~ecommended D~~d~~ietary I~~i~~ntake (RDI) for older adults 71+ years is less than for younger adults[(16)]. Of the micronutrients, the RDI for riboflavin and calcium are higher for adults over 70 years than for younger adults.

The Aadequate Iintake (AI) for vitamin D (for which there is no RDI) is also higher for this age group.

Data on micronutrient intake in advanced age is limited. Older people in the New Zealand Adult Nutrition Survey (NZANS) are under-represented; data from participants over 70 years and Māori aged over 50 years were aggregated thus reducing the utility of the data for those in advanced age. This is problematic as many micronutrient recommendations differ for adults aged over 50 years and beyond[17]. Further, oOlder Māori consume different foods according to their cultural preferences and this may result in different nutrient intakes[18]. Based on the estimated average requirement (EAR) for men and women aged over 70 years, data from the latest NZANS 2008/09 showed a higher estimated prevalence of low intake of calcium, zinc, selenium, riboflavin and vitamin B_6 was established compared to younger age groups[19]. Multiple micronutrient inadequacies in older people have been reported elsewhere[7; 20]. A relevant comprehensive analysis to identify micronutrient intake and foods sources of micronutrients in people of advanced age is lacking. The aim of this paper was to examine energy and micronutrient intake, and the contribution of food groups to that intake, in Māori and non-Māori participating in LiLACS NZ.

Methods

LiLACS NZ is a population based cohort study of Māori aged 80-90 years and non-Māori aged 85 years at inception in 2010. Detailed methods have been reported[21; 22]. Younger Maori participants were recruited at a younger age as the gap in life expectancy between Maori and non-Maori was 8.2 years for men and 8.8 years for women[23]. At inception (Wave 1), the sample consisted of 421 Māori and 516 non-Māori. In brief, participants were identified from the electoral roll, health care databases and extensive family and personal networks and were recruited by personal invitation from the general practitioner or community contact. Those meeting the age criteria and living within geographical boundaries of the District Health Boards of the Bay of Plenty and northern part of the Lakes areas were eligible. The sample recruited were roughly representative of the age structure of the Māori population. Non-Māori women were slightly underrepresented compared with the NZ population[21].

Wave 2, ~~A~~ 12-month follow up visit, was completed in 2011 and dietary intake was assessed in 216 Māori and 362 non-Māori octogenarians using two ~~repeat~~ 24 hour Multiple Pass Recalls (24h x 2 MPR) on two different days. Of the 267 Māori who took part in the 12-month interviews 216 (81%) ~~Māori those who~~ completed the dietary assessment. Those Māori completing the dietary assessment ~~216 (81%)~~ did not differ from ~~Māori~~ those who did not in; living arrangement, gender, age or depression status. ~~, and~~ O~~o~~f the 403 non-Māori who took part in the 12-month interviews 362 (90%) completed the dietary assessment; ~~-~~ those ~~Non- Māori~~ who completed the dietary assessment did not differ from ~~from non-Māori~~ those who did not complete the assessment ~~-~~in living arrangement~~-~~, gender, age or ~~and~~ depression status.

Supplements (vitamins, minerals and multivitamins) were recorded by direct observation of pill bottles and recorded in detail by trained interviewers. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Northern X Regional Ethics Committee (NXT 09/09/088) in 2009~~-~~. Written informed consent was obtained from all study participants.

Measures

In brief ~~the baseline interview gathered~~ socio-demographic information was gathered at the Wave 1, baseline ~~;~~interview; living arrangement was categorised as living alone, with spouse only or with others (family members or in residential care). The New Zealand deprivation index (NZ Dep) was used to estimate socioeconomic position[24; 25]. Weight was measured using the Tanita digital measuring scale (BC-541, Tanita Corporation, Japan) and height using a portable stadiometer following established protocols[26]. Demispan was used to estimate height for those who were not able to stand[27]. Basal Metabolic rate (BMR) was calculated using the Fredrix equation[28]. Functional status was assessed with the Nottingham Extended Activities of Daily Living (NEADL)[29] which is a measure of independence in physical function. The NEADL asks whether the older person 'does' a range of activities 'on their own, on their own with difficulty, with help, or not at all'. There are 22-items covering four domains: mobility, in the kitchen, domestic tasks and leisure activities. A higher score indicates a higher level of function.

Dietary assessment, Nutrient and Food Group ~~and Nutrient~~ Analysis

At Wave 2, 12 months follow up, LiLACS NZ participants completed a ~~24h Multiple Pass Recall (~~24h MPR~~)~~[30] on two separate days of the week conducted by trained interviewers and FOODfiles (2010), an electronic subset of data from the NZ Food Composition Database (NZFCDB)~~,~~ was used as the main source of food composition data[31] to calculate mean daily ~~for~~ energy and micronutrient intakes.

Nutrient analysis

The median and interquartile range (IQR) of daily energy, vitamin A, β-carotene, vitamin B_2, B_6, folate, vitamin B_{12}, E, C and D, calcium, iron, magnesium, potassium, sodium, selenium and zinc intakes were calculated for all participants and repeated excluding participants with energy intake (EI):BMR of <0.9 (as potential under-reporters) and > 2.0 (as potential over-reporters).

Food groups

Food items reported in the 24hMPR were allocated to food groups in order to calculate sources of nutrients by the type of food. Recipes were separated into the individual ingredients and these were assigned to separate food groups. The 33 food groups used in the 2008/09 NZ Adult Nutrition Survey (NZANS)[26] were used to allow national comparisons.

~~*Nutrient analysis*~~

~~The median and interquartile range (IQR) of daily energy, vitamin A, β-carotene, vitamin B_2, B_6, folate, vitamin B_{12}, E, C and D, calcium, iron, magnesium, potassium, sodium, selenium and zinc intakes were calculated.~~

Results:

Table 1 provides an overview of the social and physical characteristics of the participants and usage of dietary supplements. Thirteen percent (n=29) of Māori participants took vitamin supplements, 17% (n=37) mineral supplements and 9% (n=21) multivitamin and mineral supplements. Nearly a quarter (24%) of Māori participants took fish oils, glucosamine and

herbal supplements. ~~(Table 1).~~ A quarter of non-Māori participants took vitamin ~~s~~ (24%), supplements and 14% took multivitamin and mineral supplements. Other supplements e.g. glucosamine and herbal supplements were taken by 37% of non-Māori participants.

The median daily energy, vitamin and mineral intake for Māori and non-Māori participants by gender and per- MJ of daily total energy intake is shown in Tables 2 and 3. While men generally had a higher energy intake, women had ~~more~~ intakes of higher nutrient density (nutrient/MJ) ~~e intakes~~ in~~of~~ folate, vitamin C, calcium, magnesium, potassium, vitamin A (non-Māori) and β-carotene (Māori) compared to men ($p<0.05$). Median energy intake was higher for Māori men than Māori women whereas intake per MJ of; β-carotene, folate, vitamin C, calcium, magnesium, and potassium, was higher in ~~lower in~~ Māori women compared with Māori men ~~women~~. When controlling for age and physical function β-carotene, folate, vitamin C, calcium and magnesium were~~are~~ no longer significantly different but vitamins B_2, B_{12}, E, D, iron, sodium, selenium and zinc become significantly different for Māori (Table 2). For non-Māori m~~M~~edian energy, vitamin and mineral intakes were higher for men than women however when expressed per MJ energy, intakes of vitamin A, vitamin B_6, vitamin C, calcium, magnesium and potassium were higher in women than men. When controlling for age and physical function vitamins A, C and calcium are no longer significantly different but vitamin B_2, iron, sodium and zinc beca~~o~~me significantly different for non-Māori (Table 3).

The daily energy, vitamin and mineral intake by living situation and level of education for Māori and non-Māori participants are reported in Tables 4 and 5. Māori participants who lived with others (extended family n=40 or in residential care n=4) had significantly lower intakes of vitamin A, β-carotene, vitamin B_6, folate, vitamin C, magnesium and potassium compared to those who lived alone or with a spouse (Table 4). Non-Māori participants who lived with others (extended family n=23 or in residential care n=18) had significantly lower intakes of magnesium and potassium compared to those who lived alone or with a spouse controlling for age, sex and energy intake. Non~~non~~-Māori participants with a tertiary education compared to a primary or secondary education only had a higher intake of vitamin B_2, folate, calcium and potassium controlling for age, sex and energy intake (Table 5).

Differences in ~~Levels of~~ intake changed when adjusted to include- participants with a between 0.9 and 2.0 only (Table 6b) with several of the significant contrasts between Māori and non-Māori becoming non-significant, only vitamin B_6 intake remains significantly different between the two ethnic groups. Sensitivity analysis was conducted excluding those whose average energy intake suggested potential misreporting. Those excluded had significantly lower intake of vitamins B_6 and E, iron, magnesium potassium, sodium and zinc; although their reported intake was lower in all other micronutrients it was not significantly so. This is expected as 88% of Māori excluded and 70% of non- Māori excluded were deemed to be potentially underreporting (the difference between Māori and non- Māori was significant, p=0.03).

F~~Vitamin and mineral intakes and f~~ood sources: Māori participants

F~~Vitamin and mineral intakes and f~~ood sources: Non-Māori participants

Discussion

Further~~, ethnic~~, ethnic and gender differences in micronutrient intakes were evident. More than half of Māori participants did not meet the EAR for vitamin B_6; more than half of Māori and non-Māori women did not meet the EAR for folate. M~~; m~~ore than half of all participants did not meet EAR for calcium, magnesium and selenium and more than half of men did not meet EAR for zinc. Similarly, the AI for vitamin E was not met by more than half of Māori participants. Seafood is a traditional food for Māori and was a main source of Vitamin B_{12}, Vitamin D and selenium. Colonial imposed restrictions on the gathering of seafood[34] may impact on ability to maintain a desirable diet for Māori. Efforts of Māori to negotiate acceptable self-determination have been fraught[35] and those related to food gathering may contribute to inequities in health outcomes[36]. Micronutrient intake for Māori and non-Māori also differed by living situation where lower intakes were observed amongst those who lived

with others compared to those who lived alone or with a spouse. Māori had lower intakes of vitamin A, β-carotene, vitamin B_6, folate, vitamin C and both Māori and non-Māori had lower intakes of magnesium and potassium. Participants who lived with others may have had a higher degree of dependency than those who lived alone or with a spouse. Their lower micronutrient intakes may reflect higher nutritional risk commonly observed in the dependent elderly[37]. A deeper understanding of the nutrient density of food intake among this vulnerable group is required.

Comparison with other studies

Low intake of vitamin B_6 in Māori women participating in LiLACS NZ confirms NZANS (42% low intake), and the Australian cohort[7] findings. More than half of Māori women and all men in the current study appeared to consume~~take~~ less vitamin E than recommended, less than older Australian women[7]; a ~~similar~~ level~~s~~ of inadequacy ~~were~~ not found ~~shown~~ in the NZANS.

Dietary calcium has recently been emphasised in favour of supplementation due to an unexpected finding that calcium supplementation was associated with increased cardiovascular events in osteoporosis ~~trials~~trials [41; 42]. However across most studies of older people, dietary calcium intake does not meet dietary recommendations [7; 43; 44], as in LiLACS NZ; NZANS for women over 70 years[19], women in Mosgiel[38], and older women in Australia[7]. Calcium is not as well absorbed by the oldest age group[16] and thus suggestions that increased intake is needed seem reasonable. New ways of increasing dietary intake and intervention trials that study dose–response relationships to outcomes are needed as not enough is known about calcium requirements during ageing[45].

The EAR for magnesium was not met by most LiLACS NZ participants. Magnesium requirements may change with age[46] but clear conclusions are absent to set higher requirements[47]. Data from the National Health and Nutrition Examination Survey (NHANES) III showed a progressive decrease in daily magnesium intake with age[39] with mean intakes for older men (225mg) and women (166mg) being well below the recommended daily allowance (RDA). A comprehensive review suggests that the dietary intake of magnesium is inadequate in other elderly populations[48], as was observed in

Mosgiel[38]. Although magnesium is widely distributed in the food supply, it seems that older adults are less likely that younger adults to consume sufficient magnesium to meet their needs[49].

Selenium intakes were similarly marginal with over two-thirds of participants falling below the EAR, similar to the NZANS for those aged over 70 years. Selenium intake of the Mosgiel population was reported as adequate[38] however the level of intake was lower than that observed in LiLACS NZ participants. Whole population estimates from NHANES, do not show similar low intakes[50; 51] and Alaskans are not deficient in selenium[52]. New Zealand soils are low in selenium and New Zealand population blood selenium concentrations remain lower than those reported in other Western countries [53]. However in the USA, frail older people have found to be ~~are~~ more likely to be deficient in selenium than other population groups ~~in the USA~~[54]. Intakes observed here need to be examined in relationship to serum levels and outcomes over time to fully understand the significance of low intake.

Most men did not meet the EAR for zinc intake, similar to the NZANS where the highest prevalence of low intake for zinc across all age groups was for men aged 71+ years (90%) compared with only 28% of women. The Mosgiel study reported 26% of men and 53% women had intakes below two thirds of the RDA[38]. However, these findings should be interpreted with caution as the EAR for those aged over 70 years is based on experimental data from younger age groups and may be set too high for men.

~~*Energy density and M*~~*m*~~*icronutrient density*~~*s*~~

Micronutrients of concern

The high prevalence of low magnesium intake observed in LiL~~l~~ACS is potentially important and of concern due to its role in muscle function and age-related decline in physical performance[61]. Low magnesium intakes are also associated with lower bone mineral density in women [62]. Chronic magnesium deficiency results in oxidative stress and low grade inflammation[63] and through activating the inflammatory process is proposed to be involved in the aging process itself[49]. Bread was the main food source of magnesium; further efforts

may be needed to ensure older people consume an adequate intake of green vegetables, peas, beans, nuts and other sources of magnesium such as fish and seafood.

Selenium has a vital role as an antioxidant, in the regulation of the thyroid and immune function and may be important for maintenance of brain function[64]. For Māori, traditional foods such as seafood were the highest source of selenium which reinforces the importance of culturally significant foods, The inclusion of two Brazil nuts daily has been proposed as an effective way to improve selenium status and negate the need for fortification or supplementation [65] and could be acceptable to older people especially if ground and incorporated into other foods.

For zinc the highest prevalence of low intake was for non- Māori men. Expressed on a MJ food energy basis, zinc~~Zn~~ intake was 1.2~~-~~mg/MJ slightly lower than for European men (aged 70+y) in the Zenith study[66]. Data are lacking on zinc status during normal ageing and the implications of low intake is unknown however an adequate intake of zinc is important for oxidative stress, immunity and cognitive functions[67]. We found b~~B~~eef and veal, bread and milk were the main contributors to zinc intake which is similar to findings for adults aged 71+ in the NZANS.

Supplement Usage~~s~~

Supplements users tended to have overall better dietary intakes being ~~to be~~ more likely than non-users to meet micronutrient requirements from their diet alone. Māori men and women who took supplements were less likely to be deficient in their intake from food alone for vitamin A, folate and magnesium while non-Maori were less likely to be deficient in magnesium, potassium and zinc, but more likely to be deficient in vitamin B_{12}.

In New Zealand about a third of adults over 65 years have ~~were~~ previously been reported to be ~~The 1997 New Zealand National Nutrition survey reported a prevalence of~~ regular dietary supplement use~~rs of 21-35% by adults over 65 years~~[68]. Data fro~~r~~m the USA suggests more than half of older adults use dietary supplements[69] and supplement use increases with age[70]. Supplement users are cited to be more likely to eat a balanced diet than non-users[70]~~.,~~ and this may reflect that taking supplements is part of an overall ~~-~~effort to improve health and

wellness. Micronutrient requirements can however be achieved within a healthy well balanced diet which meets energy and macronutrient recommendations. Educational efforts to decrease the prevalence of micronutrient shortfalls need to focus on ~~increasing~~improving dietary intake -and dietary variety and on improving the opportunity for older people to eat with others which has been shown to improve dietary intake[13]. ~~-thus other methods to increase dietary intake may be needed, such as food fortification with key micronutrients.~~

The micronutrient reference values and recommendations for intakes for New Zealanders were developed based on very low number of people in the older age groups or extrapolation from younger age groups and may bear no relationship to positive nutrition related outcomes in older people. The micronutrient reference values and recommendations for intakes are presented as units of intake or a range of intakes regardless of body size or functional status factors which are arguably more variable in older people than younger groups. Our study showed large variability in both absolute and energy adjusted intakes. One main limitation of comparing absolute intake to recommendations must be that interpretation is difficult for this age group where variation in underlying functional and anthropometric status is so great and data on actual micronutrient requirements~~status~~ is lacking.

A further limitation is also the lack of qualitative dialogue to accompany the quantitative data presented here telling only part of the story, particularly for Māori ~~Maori~~. Food is an important cultural activity for Māori. This design ~~tha~~t does not take into account the cultural value of food, the wairua, spiritual significance of foods from a Māori ~~Maori~~ perspective, which may equally impact nutrition related outcomes.

Results need to be interpreted in light of considerations of potential inaccuracy in dietary recall related to cognitive decline in advanced age. We used the most acceptable and validated dietary assessment available[30] and provided training, support and quality assurance. It is of concern that potential misreporting was more prevalent amongst Māori; a greater proportion of reports were outside the EI:BMR of between 0.9 and 2.0, and this may have impacted observed ethnic differences in dietary intake for some micronutrients (Table 6b). However the relevance and accuracy of the EI:BMR developed for younger age groups

and here applied to octogenarians is not known. In further sensitivity analyses we will examine differences in associations with outcomes. ~~for those within and outside the EI:BMR of between 0.9 and 2.0.~~

Conclusions.

Table 1 Social, physical and health characteristics of Māori and non-Māori participants by gender

	Māori			Non-Māori		
	Men	**Women**	**Total**	**Men**	**Women**	**Total**
Number	92	124	216	172	190	362
Age (years) Median (IQR)	82 (81, 85)	83.5 (81, 86)	83 (81, 85)	86 (85, 86)	86 (85, 86)	86 (85, 86)
Living arrangement n (%)						
Alone	19 (25)	54 (51)	73 (40)	61 (37)	120 (65)	181 (52)
Spouse only	35 (45)	19 (18)	54 (30)	96 (57)	31 (17)	127 (36)
With others*	23 (30)	33 (31)	56 (30)	10 (6)	33 (18)	43 (12)
Deprivation, NZDep score n(%)						
1- 4 least	12 (13)	25 (20)	37 (17)	46 (27)	44 (23)	90 (25)
5- 7	26 (28)	23 (19)	49 (23)	73 (42)	84 (44)	157 (43)
8- 10 most	54 (59)	76 (61)	130 (60)	53 (31)	62 (33)	115 (32)
Smoking n(%)						
Never	29 (32)	63 (53)	92 (43)	62 (36)	130 (68)	192 (53)
Current	10 (11)	16 (13)	26 (12)	11 (6)	6 (3)	17 (5)
Former	53 (58)	41 (34)	94 (44)	99 (58)	54 (28)	153 (42)
Alcohol n(%)						
Never	32 (42)	51 (48)	83 (46)	31 (18)	73 (40)	104 (29)
Monthly or less	12 (16)	22 (21)	34 (19)	23 (14)	41 (22)	64 (18)
2-4 times a month	7 (9)	10 (9)	17 (9)	19 (11)	20 (11)	39 (11)
2-3times a week	7 (9)	7 (7)	14 (8)	20 (12)	18 (10)	38 (11)
≥4 times a week	18 (24)	16 (15)	34 (19)	76 (45)	32 (17)	108 (31)
Dietary supplement Usage n(%)						
Vitamins	10 (11)	19 (15)	29 (13)	26 (15)	62 (31)	88 (24)
Minerals	14 (15)	23 (18)	37 (17)	31 (18)	52 (26)	83 (23)
Multivitamins & minerals	6 (6)	15 (12)	21 (9)	19 (11)	32 (16)	51 (14)
Other**	19 (20)	34 (26)	53 (24)	51 (30)	83 (42)	134 (37)
Weight, kg Median (IQR)	74.8 (64.1,85.4)	65.8 (57, 77.9)	69.7 (59.8, 1.2)	74.3 (67.9, 2.1)	63.8 (57.3, 72)	70.2 (60.8, 78)
BMI, kg/m^2 Median (IQR)	27.9 (25.4,31.1)	28.7 (24.0,31.6)	28.3 (24.7,31.4)	26.2 (24.2,28.5)	26.4 (23.7,30.0)	26.2 (24.0,29.2)
BMR, kcal/day Median (IQR)	1586 (1471,1734)	1284 (1171,1411)	1393.5 (1221,1598)	1571 (1468,1674)	1195 (1121,1275)	1353 (1189,1569)
Physical Function n(%) NEADL	15.4 (4.8)	16.9 (4.5)	16.3 (4.7)	16.5 (3.9)	16.9 (4.8)	16.7 (4.4)

*With others includes living with extended family, and 8 participants in residential care

** fish oils, glucosamine and herbal

IQR, interquartile range, GDS, Geriatric Depression Scale; PASE, Physical Activity Scale for the Elderly, higher score means more activity, NEADL, Nottingham Extended Activities of Daily Living score[29]

Table 2. Daily energy, vitamin and mineral intake from food for Māori participants by gender and per MJ of energy.

Micronutrients	All		Men			Women				
	Median	IQR	Median	IQR	Per 1 MJ	Median	IQR	Per 1 MJ	P-value*	P-value#
Energy (MJ)	6.4	5.2 - 8.2	7.4	6.1 - 9.1	-	6.0	4.8 - 7.2	-	<.0001	<.0001
Vitamins										
Vitamin A (µg RE)	859	549 - 1278	1020	559 - 1405	123.0	829	541 - 1169	136.0	0.143	0.133
β-Carotene (µg)	3011	1228 - 4946	2805	1014 - 5310	354.5	3102	1310 - 4923	453.8	0.023	0.399
Vitamin B_2 (mg)	1.6	1.1 – 2.0	1.7	1.2 - 2.3	0.2	1.5	1.1 – 2.0	0.2	0.346	0.003
Vitamin B_6 (mg)	1.2	0.9 - 1.7	1.3	1.0 - 1.8	0.2	1.2	0.9 - 1.7	0.2	0.187	0.065
Folate (µg)	199	156 - 262	206	160 - 271	28.5	193	151 - 252	32.2	0.002	0.076
Vitamin B_{12} (µg)	3.0	1.9 - 4.4	3.4	2.5 - 5.1	0.5	2.7	1.7 - 3.9	0.5	0.199	0.027
Vitamin E (mg)	7.0	4.8 - 9.4	7.7	5.4 - 10.6	1.0	6.4	4.6 - 8.9	1.0	0.088	0.021
Vitamin C (mg)	71.6	46.1 - 124.3	74.5	43.3 - 120.5	10.7	70.6	47.1 - 126.5	12.8	0.016	0.734
Vitamin D (µg)	3.2	1.8 - 5.7	3.8	2.4 - 7.2	0.5	3.0	1.7 - 4.5	0.5	0.443	0.005
Minerals										
Calcium (mg)	563	424 - 778	578	414 - 859	76.2	543	433 - 765	94.1	0.009	0.139
Iron (mg)	9.7	7.1 - 13.1	11.2	7.8 - 14.4	1.4	8.9	6.7 - 11.9	1.5	0.377	0.001
Magnesium (mg)	217	179 - 272	235	188 - 286	32.1	208	162 - 258	35.5	0.004	0.053
Potassium (mg)	2374	1883 - 3006	2624	2055 - 3332	334.3	2250	1809 - 2805	379.5	0.004	0.0004
Sodium (mg)†	2305	1760 - 3124	2720	1809 - 3351	348.7	2169	1660 - 2770	364.2	0.281	0.0003
Selenium (µg)	37.8	25.2 - 59.8	44.3	31.8 - 66.6	6.3	32.4	22.4 – 57.0	5.8	0.577	0.016
Zinc (mg)	7.7	5.8 - 10.5	8.9	6.8 - 13	1.2	7.1	5.3 - 9.1	1.2	0.778	0.0001

†

Does not include intake from supplements, energy from alcohol, table salt and salt for cooking
MJ mega joule, IQR, Interquartile Range; RE, Retinol Equivalents
* Mann-Whitney U test for no sex difference (Per 1 MJ of energy)
# comparing all men and all women, multivariate generalised linear model controlling for age and ~~physical~~ functional status from the Nottingham Extended Activities of Daily Living Scale (NEADL) score[29].

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Table 3. Daily energy, vitamin and mineral intake from food for non-Māori participants by gender and per MJ of energy.

Micronutrients	All		Men			Women				
	Median	IQR	Median	IQR	Per 1 MJ	Median	IQR	Per 1 MJ	P-value*	P-value#
Energy (MJ)	7.0	5.8 - 8.7	7.9	6.7 - 9.6	-	6.3	5.3 - 7.5	-	<.0001	≤.0001
Vitamins										
Vitamin A (µg RE)	904	628 - 1278	981	672 - 1323	115.9	867	571 - 1230	141.6	0.01	0.606
β-Carotene (µg)	3029	1823 - 4937	3325	1960 - 5163	406.6	2831	1809 - 4485	431.4	0.15	0.195
Vitamin B_2 (mg)	1.8	1.4 - 2.3	2.0	1.5 - 2.5	0.2	1.6	1.2 - 2.2	0.3	0.062	≤.0001
Vitamin B_6 (mg)	1.4	1.1 - 1.9	1.5	1.2 - 2.1	0.2	1.4	1.1 - 1.7	0.2	0.001	0.012
Folate (µg)	233	178 - 298	245	192 - 316	30.2	215	163 - 285	33.9	0.002	0.0001
Vitamin B_{12} (µg)	3.0	2.1 - 4.2	3.6	2.4 - 4.8	0.5	2.6	1.8 - 3.6	0.4	0.37	0.162
Vitamin E (mg)	8.4	6.2 - 11.5	9.5	7.2 - 11.8	1.1	7.6	5.5 - 10.5	1.2	0.054	0.215
Vitamin C (mg)	85.4	54.2 - 135.8	85.6	57.5 - 136.6	10.5	84.5	51.2 - 133.8	13.2	0.002	0.881
Vitamin D (µg)	3.7	2.3 - 5.9	4.1	2.8 - 6.3	0.5	3.4	2.0 - 5.5	0.5	0.613	0.086
Minerals										
Calcium (mg)	702	541 - 905	731	582 - 928	88.8	679	507 - 852	109.2	<.0001	0.193
Iron (mg)	10.6	8.1 - 13.3	11.6	9.9 - 14.3	1.4	9.3	7.1 - 11.7	1.4	0.693	≤.0001
Magnesium (mg)	258	214 - 321	276	229 - 331	33.9	244	190 - 309	38.6	<.0001	0.004
Potassium (mg)	2755	2243 - 3285	2994	2544 - 3450	361.8	2508	2118 - 3087	400.2	0.0001	≤.0001
Sodium (mg)†	2485	1869 - 3147	2764	2278 - 3377	348.1	2189	1658 - 2823	342.3	0.996	≤.0001
Selenium (µg)	39.5	27.0 - 56.5	45.8	32.6 - 61.2	5.3	34.0	24.6 - 47.6	5.1	0.345	0.232
Zinc (mg)	8.4	6.5 - 10.3	9.4	7.6 - 11.2	1.2	7.4	5.8 - 9.3	1.2	0.43	≤.0001

†Does not include intake from supplements, energy from alcohol, table salt and salt for cooking
MJ Mega Joule, IQR, Interquartile Range; RE, Retinol Equivalents
* Mann-Whitney U test for no sex difference (Per 1 MJ of energy)
# comparing all men and all women, multivariate generalised linear model controlling for physical functional status from the Nottingham Extended Activities of Daily Living Scale (NEADL) score.[29]

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Table 4. Daily energy, vitamin and mineral intake from food for Māori participants by living situation and education

Micronutrients	Living Situation			Education			
	Alone (n=73)	Spouse only (n=54)	With Others (n=56)	Primary only (n=65)	Secondary (n=123)	Trade qualification (n=7)	Tertiary (n=16)
Energy (MJ)	6.3	7.1	6.4	6.7	6.3	6.3	6.1
Vitamins							
Vitamin A (µg RE)	954	1141	760*	1046	764	954	937
β-Carotene (µg)	3292	3849	2344**	3137	2661	4823	3826
Vitamin B_2 (mg)	1.5	1.7	1.6	1.6	1.6	1.6	1.7
Vitamin B_6 (mg)	1.4	1.5	1.1**	1.2	1.2	1.5	1.2
Folate (µg)	216	232	191*	189	206	186	187
Vitamin B_{12} (µg)	3.2	3.2	2.9	2.9	3.0	1.9	3.3
Vitamin E (mg)	7.6	7.8	6.1	7.2	6.6	7.1	6.7
Vitamin C (mg)	76.3	96.5	65.1**	68.2	72.0	67.4	94.0
Vitamin D (µg)	2.9	3.3	3.3	3.3	2.9	3.5	3.3
Minerals							
Calcium (mg)	546	633	582	543	565	586	744
Iron (mg)	9.5	11.0	9.5	10.7	9.5	9.2	10.1
Magnesium (mg)	217	260	202**	203	224	259	209
Potassium (mg)	2370	2806	2304**	2370	2367	2752	2637
Sodium (mg)[†]	2315	2513	2271	2290	2304	2370	2304
Selenium (µg)	34.7	41.3	41.6	43.7	34.7	42.9	35.5
Zinc (mg)	8.1	8.4	7.2	7.8	7.5	8.9	7.4

*p<0.05 **p<0.01 ***p<0.001 comparing all living situations or all education levels, multivariate generalised linear model controlling for age, sex and energy intake.

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Table 5. Daily energy, vitamin and mineral intake from food for non-Māori participants by living situation and education

Micronutrients	Live With			Education			
	Alone (n=181)	Spouse only (n=127)	With Others (n=43)	Primary only (n=63)	Secondary (n=199)	Trade qualification (n=42)	Tertiary (n=55)
Energy (MJ)	6.7	7.7	6.6	7.1	6.9	6.7	7.7
Vitamins							
Vitamin A (µg RE)	904	920	776	869	919	884	1076
β-Carotene (µg)	3291	2888	2816	2328	3247	2676	3522
Vitamin B_2 (mg)	1.7	1.9	1.6	1.8	1.7	1.7	2.3*
Vitamin B_6 (mg)	1.5	1.4	1.2	1.3	1.4	1.4	1.6
Folate (µg)	237	240	204	222	229	238	272*
Vitamin B_{12} (µg)	2.8	3.6	2.5	2.8	2.9	3.2	3.7
Vitamin E (mg)	7.9	9.7	7.4	8.0	8.5	8.3	9.9
Vitamin C (mg)	92.6	87.4	75.9	76.8	85.5	80.2	109.7
Vitamin D (µg)	3.5	4.2	3.7	3.9	3.5	3.6	3.9
Minerals							
Calcium (mg)	705	720	701	757	693	635	809*
Iron (mg)	10.2	11.1	9.6	10.3	10.5	10.3	11.3
Magnesium (mg)	261	260	215**	254	255	262	290
Potassium (mg)	2761	2830	2342***	2633	2724	2601	3133*
Sodium (mg)[†]	2344	2739	2510	2373	2544	2214	2721
Selenium (µg)	39.2	41.1	37.9	39.1	39.9	38.2	42.4
Zinc (mg)	8.1	8.9	6.5	8.3	8.1	8.5	9.4

*p<0.05 **p<0.01 ***p<0.001 comparing all living situations or all education levels, multivariate generalised linear model controlling for age, sex and energy intake.

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Table 6a. Proportion of Māori and non-Māori participants who did not meet the Nutrient Reference Values (NRV) for Australia and New Zealand (NHMRC 2006) for daily intake of micronutrients.

Micronutrients	Women n (%)		Women >-70 years NRV	Men-n (%)		Men >-70 years NRV	p-value Gender	p-value Ethnic Group~~Maori~~
	Māori	Non Māori		Māori	Non Māori			
Vitamins								
Vitamin A (µg RE)	27 (21.8)~~21.8~~	35 (18.4)~~18.4~~	EAR 500	30 (32.6)~~32.6~~	34 (19.8)~~19.8~~	EAR 625	0.1454	0.0249
Vitamin B_1 (mg)	25 (20.2)~~20.2~~	26 (13.7)~~13.7~~	EAR 0.7	22 (23.9)~~23.9~~	16 (9.3)~~9.3~~	EAR 0.9	0.6344	0.0064
Vitamin B_2 (mg)	29 (23.4)~~23.4~~	37 (19.5)~~19.5~~	EAR 1.1	29 (31.5)~~31.5~~	27 (15.7)~~15.7~~	EAR 1.3	0.8757	0.0389
Vitamin B_6 (mg)	77 (62.1)~~62.1~~	78 (41.1)~~41.1~~	EAR 1.3	51 (55.4)~~55.4~~	79 (45.9)~~45.9~~	EAR 1.4	0.9113	0.0003
Folate (µg)	72 (58.1)~~58.1~~	112 (59)~~59~~	EAR 320	53 (57.6)~~57.6~~	74 (43)~~43~~	EAR 320	0.0122	0.1421
Vitamin B_{12} (µg)	43 (34.7)~~34.7~~	57 (30)~~30~~	EAR 2.0	12 (13)~~13~~	21 (12.2)~~12.2~~	EAR 2.0	<.0001	0.1446
Vitamin E (mg)	71 (57.3)~~57.3~~	80 (42.1)~~42.1~~	AI 7	67 (72.8)~~72.8~~	96 (55.8)~~55.8~~	AI 10	0.001	0.0016
Vitamin C (mg)	16 (12.9)~~12.9~~	13 (6.8)~~6.8~~	EAR 30	11 (12)~~12~~	15 (8.7)~~8.7~~	EAR 30	0.626	0.0068
Vitamin D (µg)	121 (97.6)~~97.6~~	186 (97.9)~~97.9~~	AI 15.0	88 (95.7)~~95.7~~	166 (96.5)~~96.5~~	AI 15.0	0.2813	0.9385
Minerals								
Calcium (mg)	116 (93.6)~~93.6~~	165 (86.8)~~86.8~~	EAR 1100	84 (91.3)~~91.3~~	152 (88.4)~~88.4~~	EAR 1100	0.9384	0.0697
Iron (mg)	14 (11.3)~~11.3~~	15 (7.9)~~7.9~~	EAR 5	11 (12)~~12~~	3 (1.7)~~1.7~~	EAR 6	0.1124	0.003
Magnesium (mg)	99 (79.8)~~79.8~~	120 (63.2)~~63.2~~	EAR 265	78 (84.8)~~84.8~~	140 (81.4)~~81.4~~	EAR 350	0.0001	0.0031
Potassium (mg) AI	93 (75)~~75~~	121 (63.7)~~63.7~~	AI 2800	83 (90.2)~~90.2~~	147 (85.5)~~85.5~~	AI 3800	<.0001	0.0059
Sodium (mg)[†]	122 (98.4)~~98.4~~	180 (94.7)~~94.7~~	AI 460-920	91 (98.9)~~98.9~~	172 (100)~~100~~	AI 460-920	0.0242	0.4457
Selenium (µg)	87 (70.2)~~70.2~~	145 (76.3)~~76.3~~	EAR 50	65 (70.7)~~70.7~~	127 (73.8)~~73.8~~	EAR 60	0.7243	0.8986
Zinc (mg)	50 (40.3)~~40.3~~	67 (35.3)~~35.3~~	EAR 6.5	64 (69.6)~~69.6~~	140 (81.4)~~81.4~~	EAR 12	<.0001	0.3353

[†] AI for all adult men and women, -n(%)~~N (%) above~~ below the NRV presented for each group. NRV Nutrient Reference Value, EAR Estimated Average Requirement, AI Adequate Intake

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Table 6b. Proportion of Māori and non-Māori participants with a EI:BMR of between 0.9 and 2.0 who did not meet the Nutrient Reference Values (NRV) for Australia and New Zealand (NHMRC 2006) for daily intake of micronutrients.

Micronutrients	Women n(%)		Women >70 years NRV	Men n(%)		Men >70 years NRV	p-value Gender	p-value Ethnic Group
	Māori	Non Māori		Māori	Non Māori			
Vitamins								
Vitamin A (µg RE)	13 (18.1)~~18.1~~	24 (17.8)~~17.8~~	EAR 500	10 (22.2)~~22.2~~	22 (17.6)~~17.6~~	EAR 625	0.778	0.638
Vitamin B_1 (mg)	10 (13.9)~~13.9~~	13 (9.6)~~9.6~~	EARI 0.7	6 (13.3)~~13.3~~	9 (7.2)~~7.2~~	EAR/RDI 0.9	0.557	0.124
Vitamin B_2 (mg)	10 (13.9)~~13.9~~	19 (14.1)~~14.1~~	EAR 1.1	9 (20)~~20~~	21 (16.8)~~16.8~~	EAR 1.3	0.322	0.747
Vitamin B_6 (mg)	42 (58.3)~~58.3~~	48 (35.6)~~35.6~~	EAR 1.3	19 (42.2)~~42.2~~	50 (40)~~40~~	EAR 1.4	0.760	0.004
Folate (µg)	36 (50)~~50~~	79 (58.5)~~58.5~~	EAR 320	22 (48.9)~~48.9~~	52 (41.6)~~41.6~~	EAR 320	0.020	0.723
Vitamin B_{12} (µg)	21 (29.2)~~29.2~~	38 (28.2)~~28.2~~	EAR 2.0	2 (4.4)~~4.4~~	14 (11.2)~~11.2~~	EAR 2.0	<.001	0.790
Vitamin E (mg)	38 (52.8)~~52.8~~	52 (38.5)~~38.5~~	AI 7	31 (68.9)~~68.9~~	63 (50.4)~~50.4~~	AI 10	0.012	0.093
Vitamin C (mg)	8 (11.1)~~11.1~~	4 (3)~~3~~	EAR 30	1 (2.2)~~2.2~~	10 (8)~~8~~	EAR 30	0.710	0.231
Vitamin D (µg)	69 (95.8)~~95.8~~	133 (98.5)~~98.5~~	AI 15.0	44 (97.8)~~97.8~~	119 (95.2)~~95.2~~	AI 15.0	0.338	0.580
Minerals								
Calcium (mg)	65 (90.3)~~90.3~~	120 (88.9)~~88.9~~	EAR 1100	42 (93.3)~~93.3~~	113 (90.4)~~90.4~~	EAR 1100	0.524	0.597
Iron (mg)	5 (6.9)~~6.9~~	5 (3.7)~~3.7~~	EAR 5	2 (4.4)~~4.4~~	0 (0)~~0~~	EAR 6	0.086	0.076
Magnesium (mg)	53 (73.6)~~73.6~~	88 (65.2)~~65.2~~	EAR 265	36 (80)~~80~~	99 (79.2)~~79.2~~	EAR 350	0.0114	0.244
Potassium (mg)	50 (69.4)~~69.4~~	88 (65.2)~~65.2~~	AI 2800	38 (84.4)~~84.4~~	106 (84.8)~~84.8~~	AI 3800	<.001	0.399
Sodium (mg)[†]	71 (98.6)~~98.6~~	134 (99.3)~~99.3~~	AI 460-920	45 (100)~~100~~	125 (100)~~100~~	AI 460-920	0.971	0.265
Selenium (µg)	52 (72.2)~~72.2~~	108 (80)~~80~~	EAR 50	31 (68.9)~~68.9~~	88 (70.4)~~70.4~~	EAR 60	0.097	0.884
Zinc (mg)	21 (29.2)~~29.2~~	42 (31.1)~~31.1~~	EAR 6.5	28 (62.2)~~62.2~~	104 (83.2)~~83.2~~	EAR 12	<.001	0.354

[†] AI for all adult men and women, n (%) below the NRV ~~N (%)~~ presented for each group. NRV Nutrient Reference Value, EAR Estimated Average Requirement, AI Adequate Intake

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Table 7. Percent of Māori and non-Māori participants who did not meet the Nutrient Reference Values for Australia and New Zealand (NHMRC 2006) for daily intake of micronutrients from food only -by whether the participants used supplements or not.

~~Comparison of the proportion (%) of Māori and non-Māori whose dietary intake did not meet recommendations by whether the patrticipant used supplements or not usage.~~

Māori ~~Maori~~				
Vitamins ~~Micronutrients~~	All	No supplement uses~~s~~	Used s~~S~~upplements	P-value*
~~Vitamins~~	-	-	-	-
Vitamin A (µg RE)	24.4	35.1	12.1	0.0004
Vitamin B_1 (mg)	20.6	23.7	16.9	0.259
Vitamin B_2 (mg)	24.4	29.9	18.1	0.067
Vitamin B_6 (mg)	54.4	58.8	49.4	0.210
Folate (µg)	56.7	63.9	48.2	0.034
Vitamin B_{12} (µg)	23.9	26.8	20.5	0.323
Vitamin E	61.1	63.9	57.8	0.405
Vitamin C (mg)	11.1	13.4	8.4	0.292
Vitamin D (µg)	96.1	96.9	95.2	0.552
Minerals				
Calcium (mg)	92.2	94.9	89.2	0.157
Iron (mg)	8.9	12.4	4.8	0.077
Magnesium (mg)	79.4	85.6	72.3	0.028
Potassium (mg)	79.4	83.5	74.7	0.146
Selenium (µg)	68.9	70.1	67.5	0.704
Zinc (mg)	51.7	56.7	45.8	0.145
Non- Māori ~~Maori~~				
Micronutrients	All	No supplement uses~~s~~	Used s~~S~~upplements	P-value*
Vitamins				
Vitamin A (µg RE)	19.0	20.7	17.7	0.489
Vitamin B_1 (mg)	11.5	9.7	12.8	0.364
Vitamin B_2 (mg)	17.5	15.9	18.7	0.490
Vitamin B_6 (mg)	42.5	47.6	38.9	0.107
Folate (µg)	51.1	53.8	49.3	0.405
Vitamin B_{12} (µg)	21.6	13.1	27.6	0.001
Vitamin E (mg)	48.9	52.4	46.3	0.262
Vitamin C (mg)	7.5	10.3	5.4	0.085
Vitamin D (µg)	97.1	96.6	97.5	0.588
Minerals				
Calcium (mg)	87.4	89.7	85.7	0.276
Iron (mg)	4.9	4.8	4.9	0.967
Magnesium (mg)	71.8	82.1	64.5	0.0003
Potassium (mg)	73.9	80.0	69.5	0.028
Selenium (µg)	74.7	76.6	73.4	0.505

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Zinc (mg)	57.8	64.8	52.7	0.024

*p-value calculated using the Cochrane-Mantel-Haenszel test for comparison of two groups on a dichotomous response. 83 Maori took supplements; 97 did not. 203 non-Maori took supplements;145 did not.

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Conflict of Interest: None

Authorship

NK & AA conceived of the study and led its design, AR, MM-L provided Māori leadership for the study, NK RT CW KH were involved in formulating research question, AA provided specialist training for MPR, KH provided project management oversight, CW, RT, KH participated in data collection, SM RT provided statistical analyses, CW, RT, NK, AA, AR participated in manuscript preparation.

Figure Legend:

Figure 1:

Percentage of food groups contributing to micronutrient intake by ethnic group and gender for vitamin A, folate, vitamin B_{12}, vitamin D, calcium, iron, magnesium, potassium, selenium, zinc.

Milk: all milk (cow, soy, rice, goat and flavoured milk), milkshakes, milk powder
Dairy: cream, sour cream, yoghurt, dairy food, ice-cream, dairy-based dips
Cheese: cheddar, edam, specialty (blue, brie, feta etc.), ricotta, cream cheese, cottage cheese, processed cheese

Figure 2

Intake distribution of folate with the estimated average requirement (EAR) and recommended daily intake (RDI) marked for Māori and non-Māori by gender

Figure 3

Intake distribution of selenium with the estimated average requirement (EAR) and recommended daily intake (RDI) marked for Māori and non-Māori by gender

References

1. Statistics New Zealand (2013) Statistics NZ, Maori population estimates: At 30 June 1991 - 2012. Wellington.
2. Ministry of Health (2011) Tatau Kura Tangata: Health of Older Māori Chart Book Wellington: Ministry of Health.
3. Statistics NZ (2007) *New Zealand's 65+ Population" A statistical volume (2007)*. Wellington.
4. Donini L, Savina C, Rosano A *et al.* (2007) Systematic review of nutritional status evaluation and screening tools in the elderly. *Journal of Nutrition Health and Aging* **11**, 421-432.
5. Wham C, Teh R, Moyes S *et al.* (2015) Health and social factors associated with nutrition risk: Results from life and living in advanced age: A cohort study in New Zealand (LILACS NZ). *J Nutr Health Aging* **19**, 637-645.
6. Roberts SB, Rosenberg I (2006) Nutrition and Aging: Changes in the Regulation of Energy Metabolism With Aging. *Physiol Rev* **86**, 651-667.
7. Zhu K, Devine A, Suleska A *et al.* (2010) Adequacy and change in nutrient and food intakes with aging in a seven-year cohort study in elderly women. *Journal of Nutrition, Health and Aging* **14**, 723-729.
8. Drewnowski A, Evans WJ (2001) Nutrition, physical activity, and quality of life in older adults: Summary. *Journals of Gerontology - Series A Biological Sciences and Medical Sciences* **56**, 89-94.
9. Genser D (2008) Food and Drug Interaction: Consequences for the Nutrition/Health Status. *Ann Nutr Metab* **52 suppl. 1**, 29-32.
10. Donini LM, Savina C, Cannella C (2003) Eating Habits and Appetite Control in the Elderly: The Anorexia of Aging. *Int Psychogeriatr* **15**, 73-87.
11. Elmadfa I, Meyer AL (2008) Body Composition, Changing Physiological Functions and Nutrient Requirements of the Elderly. . *Ann Nutr Metab* **52**, 2-5.
12. Morley JE (2001) Decreased Food Intake With Aging. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* **56**, 81-88.
13. Locher JL, Ritchie CS, Robinson CO *et al.* (2008) A Multidimensional Approach to Understanding Under-Eating in Homebound Older Adults: The Importance of Social Factors. *Gerontologist* **48**, 223-234.
14. Heaney RP (2006) Barriers to Optimizing Vitamin D3 Intake for the Elderly. *The Journal of Nutrition* **136**, 1123-1125.
15. Inzitari M, Doets E, Bartali B *et al.* (2011) Nutrition in the age-related disablement process. *The journal of nutrition, health & aging* **15**, 599-604.
16. NHMRC (National Health and Medical Research Council) (2006) *Nutrient Reference Values for Australia and New Zealand*. Canberra: NHRMC.
17. NHMRC, MoH (2005) Nutrient Reference Values for Australia and New Zealand. http://www.nrv.gov.au/nutrients/index.htm (accessed November 2012)
18. Wham C, Maxted E, Dyall L *et al.* (2012) Korero te kai o te Rangatira: Nutritional wellbeing of Maori at the pinnacle of life. *Nutrition & Dietetics* **69**, 213-216.
19. University of Otago and Ministry of Health (2011) *A Focus on Nutrition: Key findings of the 2008/09 New Zealand Adult Nutrition Survey*. Wellington: Ministry of Health.
20. de Groot CP, van den Broek T, van Staveren W (1999) Energy intake and micronutrient intake in elderly Europeans: seeking the minimum requirement in the SENECA study. *Age Ageing* **28**, 469-474.
21. Dyall L, Kepa M, Hayman K *et al.* (2013) Engagement and recruitment of Māori and non-Māori people of advanced age to LiLACS NZ. *Aust N Z J Public Health* **37**, 124-131.
22. Hayman K, Kerse N, Dyall L *et al.* (2012) Life and living in advanced age: A cohort study in New Zealand -Te Puawaitanga o Nga Tapuwae Kia Ora Tonu, LiLACS NZ: Study protocol. *BMC Geriatr* **12**, 33.
23. Ministry of Social Development (2007) The Social Report 2007. Wellington, New Zealand: Ministry of Social Development.

24. Salmond C, P C, Atkinson J (2007) *NZDep2006 Index of Deprivation*. Wellington: Department of Public Health, University of Otago.
25. Salmond C, Crampton P, Sutton F (1998) NZDep91: a New Zealand index of deprivation. *Aust NZ J Public Health* **22**, 835-837.
26. University of Otago, Ministry of Health (2011) *Methodology Report for the 2008/09 New Zealand Adult Nutrition Survey.* Wellington: Ministry of Health
27. Hirani V, Mindell J (2008) A comparison of measured height and demi-span equivalent height in the assessment of body mass index among people aged 65 years and over in England. *Age Ageing* **37**, 311-317.
28. Fredrix EWHM, Soeters PB, Deerenberg IM *et al.* (1990) Resting and sleeping energy expenditure in the elderly. *Eur J Clin Nutr* **44**, 741-747.
29. Essink-Bot M-L, Krabbe PFM, Bonsel GJ *et al.* (1997) An Empirical Comparison of Four Generic Health Status Measures: The Nottingham Health Profile, the Medical Outcomes Study 36-Item Short-Form Health Survey, the COOP/WONCA Charts, and The EuroQol Instrument. *Med Care* **35**, 522-537.
30. Adamson A, Collerton J, Davies K *et al.* (2009) Nutrition in advanced age: dietary assessment in the Newcastle 85 plus; study. *Eur J Clin Nutr* **63**, S6-S18.
31. The New Zealand Institute for Plant & Food Research Limited (2011) New Zealand FOODfiles 2010 Version 01.: The New Zealand Institute for Plant & Food Research Limited and Ministry of Health.
32. Lökk J (2003) News and Views on Folate and Elderly Persons. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* **58**, M354-M361.
33. ter Borg S, Verlaan S, Hemsworth J *et al.* (2015) Micronutrient intakes and potential inadequacies of community-dwelling older adults: a systematic review. *Br J Nutr* **113**, 1195-1206.
34. Lock K, Leslie S (2007) *New Zealand's Quota Management System: A History of the First 20 Years*. *Motu Working Paper 07-02*. Wellington: Motu Economic and Public Policy Research.
35. Durie M (1998) *Te Mana Te Kawanatanga: The Politics of Maori Self-Determination.* Auckland: Oxford University Press.
36. Teh R, Kerse N, Kepa M *et al.* (2014) Self-rated health, health related behaviours and medical conditions of Māori and non-Māori in advanced age: LiLACS NZ. *NZ Med J* **127**, 13-29.
37. Fernández-Barrés S, Martín N, Canela T *et al.* (2016) Dietary intake in the dependent elderly: evaluation of the risk of nutritional deficit. *Journal of Human Nutrition and Dietetics* **29**, 174-184.
38. Horwath CC, Campbell AJ, Busby W (1992) Dietary survey of an elderly New Zealand population. *Nutrition Research* **12**, 441-453.
39. Ford ES, Mokdad AH (2003) Dietary Magnesium Intake in a National Sample of U.S. Adults. *The Journal of Nutrition* **133**, 2879-2882.
40. Davies K, Kingston A, Robinson L *et al.* (2014) Improving Retention of Very Old Participants in Longitudinal Research: Experiences from the Newcastle 85+ Study. *PLoS ONE* **9**, e108370.
41. Grey A, Bolland M, Reid R (2011) Calcium supplements and cardiovascular disease--picking the spin. *International Journal of Clinical Practice* **65**, 226-227; author reply 227-228.
42. Grey A, Bolland M, Reid IR (2009) Is calcium supplementation a risk factor for cardiovascular diseases in older women? *Nutr Rev* **67**, 424; author reply 425.
43. Bailey RL, Dodd KW, Goldman JA *et al.* (2010) Estimation of total usual calcium and vitamin D intakes in the United States. *J Nutr* **140**, 817-822.
44. Ahmed M, Arcand J, Schermel A *et al.* (2015) Analysis of the Dietary Intakes of Canadian Adults. *The FASEB Journal* **29**, 903.924.
45. Burckhardt P (2013) Calcium revisited: part I. *BoneKEy Reports* **2**, 433.
46. Hunt CD, Johnson LK (2006) Magnesium requirements: new estimations for men and women by cross-sectional statistical analyses of metabolic magnesium balance data. *The American Journal of Clinical Nutrition* **84**, 843-852.
47. EFSA NDA Panel (2015) Scientific Opinion on Dietary Reference Values for magnesium. *EFSA Journal* **13**, 4186-4249.

48. Vaquero MP (2002) Magnesium and trace elements in the elderly: intake, status and recommendations. *J Nutr Health Aging* **6**, 147-153.
49. Barbagallo M, Belvedere M, Dominguez LJ (2009) Magnesium homeostasis and aging. *Magnes Res* **22**, 235-246.
50. Fulgoni VL, 3rd, Keast DR, Bailey RL *et al.* (2011) Foods, fortificants, and supplements: Where do Americans get their nutrients? *J Nutr* **141**, 1847-1854.
51. Nobmann ED, Ebbesson SO, White RG *et al.* (1998) Dietary intakes among Siberian Yupiks of Alaska and implications for cardiovascular disease. *Int J Circumpolar Health* **57**, 4-17.
52. Johnson JS, Nobmann ED, Asay E *et al.* (2009) Dietary intake of Alaska Native people in two regions and implications for health: the Alaska Native Dietary and Subsistence Food Assessment Project. *Int J Circumpolar Health* **68**, 109-122.
53. Thomson CD (2004) Selenium and iodine intakes and status in New Zealand and Australia. *Br J Nutr* **91**, 661-672.
54. Smit E, Winters-Stone KM, Loprinzi PD *et al.* (2013) Lower nutritional status and higher food insufficiency in frail older US adults. *British Journal of Nutrition* **110**, 172-178.
55. Clayton PT B6-responsive disorders: A model of vitamin dependency. *J Inherited Metab Dis* **29**, 317-326.
56. Winkels RM, Brouwer IA, Siebelink E *et al.* (2007) Bioavailability of food folates is 80% of that of folic acid. *Am J Clin Nutr* **85**, 465-473.
57. Gennari C (2001) Calcium and vitamin D nutrition and bone disease of the elderly. *Public Health Nutr* **4**, 547-559.
58. Chung M, Balk EM, Brendel M *et al.* (2009) Vitamin D and calcium: a systematic review of health outcomes. *Evid Rep Technol Assess (Full Rep)*, 1-420.
59. Heaney RP (2008) Vitamin D and calcium interactions: functional outcomes. *Am J Clin Nutr* **88**, 541S-544S.
60. Rockell JE, Skeaff CM, Williams SM *et al.* (2006) Serum 25-hydroxyvitamin D concentrations of New Zealanders aged 15 years and older. *Osteoporos Int* **17**, 1382-1389.
61. Veronese N, Berton L, Carraro S *et al.* (2014) Effect of oral magnesium supplementation on physical performance in healthy elderly women involved in a weekly exercise program: a randomized controlled trial. *The American Journal of Clinical Nutrition*.
62. Orchard TS, Larson JC, Alghothani N *et al.* (2014) Magnesium intake, bone mineral density, and fractures: results from the Women's Health Initiative Observational Study. *Am J Clin Nutr* **99**, 926-933.
63. Barbagallo M, Dominguez LJ (2010) Magnesium and aging. *Curr Pharm Des* **16**, 832-839.
64. Zhang S, Rocourt C, Cheng WH (2010) Selenoproteins and the aging brain. *Mech Ageing Dev* **131**, 253-260.
65. Thomson CD, Chisholm A, McLachlan SK *et al.* (2008) Brazil nuts: an effective way to improve selenium status. *Am J Clin Nutr* **87**, 379-384.
66. Andriollo-Sanchez M, Hininger-Favier I, Meunier N *et al.* (2005) Zinc intake and status in middle-aged and older European subjects: the ZENITH study. *Eur J Clin Nutr* **59 Suppl 2**, S37-41.
67. Prasad AS, Bao B, Beck FWJ *et al.* (2004) Antioxidant effect of zinc in humans. *Free Radical Biol Med* **37**, 1182-1190.
68. Ministry of Health (1999) *NZ food: NZ people. Key results of the 1997 national nutrition survey.* Wellington: Ministry Of Health.
69. Qato DM, Alexander G, Conti RM *et al.* (2008) USe of prescription and over-the-counter medications and dietary supplements among older adults in the united states. *JAMA* **300**, 2867-2878.
70. Dickinson A, Blatman J, El-Dash N *et al.* (2014) Consumer usage and reasons for using dietary supplements: report of a series of surveys. *J Am Coll Nutr* **33**, 176-182.
71. Chan WC, Wright C, Riddell T *et al.* (2008) Ethnic and socioeconomic disparities in the prevalence of cardiovascular disease in New Zealand. *New Zealand Medical Journal* **121**, 11-20.

72. Jatrana S, Blakely T (2008) Ethnic inequalities in mortality among the elderly in New Zealand. *Australian & New Zealand Journal of Public Health* **32**, 437-443.